FEASIBILITY STUDY FOR
>Omitted Text<

320 MW Wind Farm at Kirby Switching Station
Gray County, Texas
SPP #GEN-2002-020

Xcel Energy Services, Inc.
Transmission Planning

March 27, 2003

Executive Summary

>Omitted Text< (Customer) has requested a feasibility study for the purpose of interconnecting 320 MW (in blocks of 80 MW) of wind generation in Gray County, Texas within the service territory of Southwestern Public Service Company. The proposed interconnection is at Kirby Switching Station on the 115 kV transmission system. Kirby Switching Station is located approximately 50 miles east of Amarillo.

Power flow analysis has indicated that for the powerflow cases studied, it is feasible to interconnect the 240 MW wind farm, but there will be significant transmission system reinforcements within the local Xcel Energy transmission system. Even 80 MW will require significant improvements to the local transmission system. Seventy-five (75) MW is the maximum generation without significant improvements being required. In order to maintain acceptable bus voltage, the customer may need to increase their capacitor bank on the 34.5 kV system from 15 MVAR to 30 MVAR for 75 MW of generation. This 75 MW does not address reinforcements deemed necessary as a result of the outcome of a Dynamic Stability Analysis. Stability Analysis may determine a need for system reinforcements that could not be determined by power flow analysis and this type of analysis is typically performed during the System Impact Study.

The requirements for interconnection consist of building a 115 kV interconnection facility configured in a single breaker and bus extension. If the customer’s substation facility will be built close to Kirby Switching Station (less than one mile), a Certificate of Convenience and Necessity from the Public Utility Commission of Texas will not be required.

The total cost for this 115 kV interconnection facility is estimated at $ 645 thousand dollars, which is based on estimates provided by our engineering department. The cost includes building 115 kV from the customers substation facility into Kirby Switching Station, which was estimated at 1/2 mile (this could vary once the customers substation is located) and the cost to connect the 115 kV into Kirby Switching Station. Dynamic Stability studies will provide guidance as to whether the reactive compensation can be static or must be dynamic (such as a SVC).

This feasibility study takes into account static system reinforcements triggered by other generation projects that are positioned ahead in the queue. In the event that these generation projects and the system reinforcements triggered by these projects are not built, this feasibility study may have to be revisited, potentially changing the requirements necessary for interconnecting this Customer’s 75 MW wind farm.

This study examines the feasibility of interconnecting this additional wind generation on the local Xcel Energy transmission system and it was determined that the available transmission capacity would not support any generation above 75 MW without significant improvements. In order to verify the available transmission capacity, the customer needs to request transmission service through the Southwest Power Pool (SPP) OASIS.

Introduction

The Customer is proposing the interconnection of a 320 MW wind farm in Gray County, Texas that will be situated approximately 50 miles east of the City of Amarillo, Texas. The proposed wind generating facility has a scheduled in-service date of November 30, 2005. This farm will interconnect into an existing 115 kV system at Kirby Switching Station currently owned by Xcel Energy, Inc. The interconnection point being located approximately 1/2 mile from the wind farm substation. The wind farm will consist of approximately 80 individual wind turbine generators for each block of 80 MW having a net generation capacity of 1.0 MW each.

The primary objective of this study was to determine the feasibility of interconnecting the facility and the level of acceptable generation (up to 320 MW in blocks of 80 MW) that could be added to the system without causing adverse impacts to the local Xcel Energy transmission system. In addition, this study addresses the issues of required construction inclusive of estimated costs, which are associated with the interconnection of this additional generation to the Xcel Energy transmission system.

Study Approach

This study uses the 2004 Summer Peak Model as presented to the SPP in January of 2002. The 2004 Summer Peak Model was developed using the 2003 Summer Peak Model. In the 2004 model the load in Area 526 (SPS) was scaled to develop the models. In addition, modifications to these models include all the new proposed generation projects along with the necessary system reinforcements triggered by these projects, which in relation to this project are positioned ahead in the queue.

The transmission system of primary concern in this feasibility study includes the Texas Panhandle including the Amarillo Metro area and all the Xcel Energy transmission system south of the Amarillo Metro area. In addition, adverse impacts on the transmission systems of other companies, although located in close proximity to this project site, will not be evaluated in this feasibility study.

This powerflow study was performed using the Power Technologies, Inc. (PTI) Power System Simulator/Engineering (PSS/E) program and contains a steady-state analysis using AC Contingency Checking (ACCC) with a Fixed Slope Decoupled Newton–Raphson (FDNS) solution. Thermal and voltage limit checks are set in accordance with SPP criteria, which state that for system intact conditions bus, voltages must be maintained between 0.95 – 1.05 per-unit of their nominal value. Under single element contingencies, the voltages are allowed to deviate between 0.90 – 1.05 per-unit of their nominal value. Thermal limit checks are comprised of both an A-rating and a B-rating. The A-rating is for system intact conditions, while the B-rating is an emergency rating under single element contingencies.

A comparative study approach was used in determining impacts caused by the interconnection of the 320 MW (in blocks of 80 MW) wind farm. The base case model included both the proposed new generation projects and the system reinforcements associated with those projects, which are positioned ahead in the queue, for the respective year/season studied. The cases have the Customer wind farm of 80 MW, 160 MW and 240 MW in service, and single element contingency violations within these cases were compared to the base case. The 320 MW facility was not studied because it was determined that the cost to improve the system to connect 320 MW of generation was prohibitive.

Results

The results from this study include general findings from the interconnection of the requested 320 MW (in blocks of 80 MW) and the steps taken to determine the level of generation (75 MW) that the local transmission system would permit, without the need for major additional transmission system reinforcements. The 320 MW addition was not considered because of the extensive additional facilities required for intact conditions. The addition of 240 MW of additional generation resulted in numerous low bus voltage violations and thermal overloading on the 230 kV and 115 kV during system intact conditions. Single element contingencies produced countless low bus voltage conditions in the presence of numerous thermal violations. The more detrimental contingencies were those that resulted in non-convergence due to voltage collapse in the several areas. As a result, there were 14 single element contingencies triggered non-convergent results. There was not any inexpensive solution to interconnect the 240 MW of generation. The best solutions pointed towards the construction of new transmission lines. The lack of “highway” lines emanating from this part of the Xcel Energy transmission system will need to be addressed in order to accommodate the additional generation.

Interconnection Requirements

The minimal requirements for the interconnection of the wind farm are to expand Kirby Switching Station to accommodate the new 115 kV line from the customers new substation approximately 1/2 mile from Kirby Switching Station. In addition, the customer needs to increase the capacitor banks on their 34.5 kV system in order to maintain acceptable bus voltage on the 115 kV and 230 kV (see Figure 1). Additional facilities will be required for generation above 75 MW.

Conclusion

Based on the results of this study, it is feasible to interconnect a 75 MW wind farm to the existing Xcel Energy transmission system without causing new thermal overloads within the local transmission system.

Estimated Costs

Table 1 lists the costs associated with the interconnection of the Customer's 75 MW wind farm.

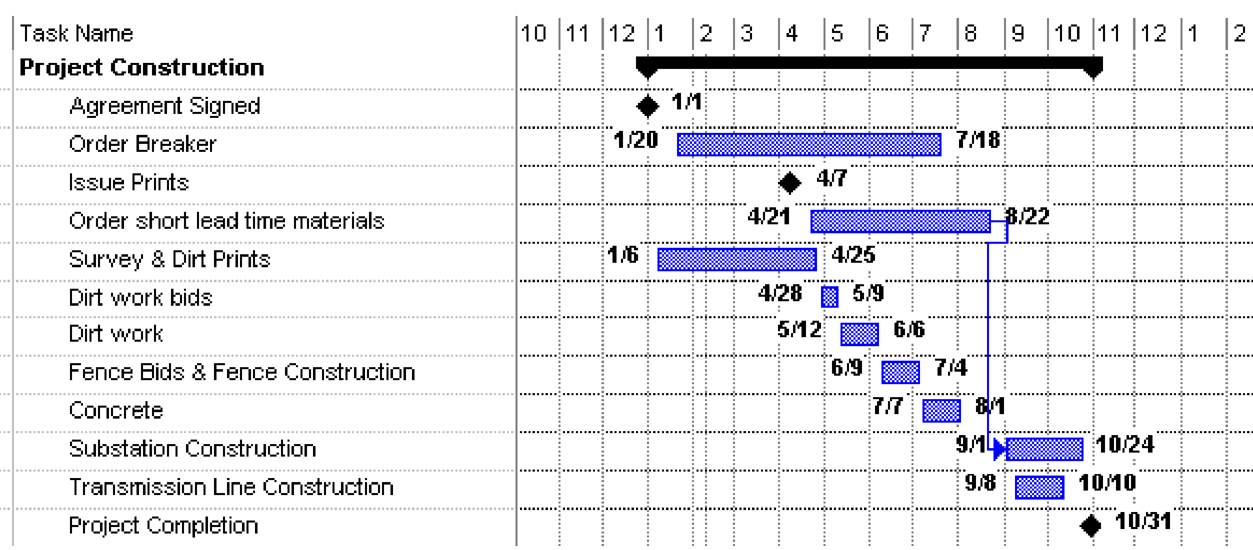
Table 1, Wind Farm Interconnection Costs

Estimated Costs	Cost
New 115 kV Interconnection Facility[1]	$ 450,000
1/2 mile Of New 115 kV Transmission Line[2]	$ 180,000
Right-Of-Way	$ 15,000
Total	***$ 645,000***

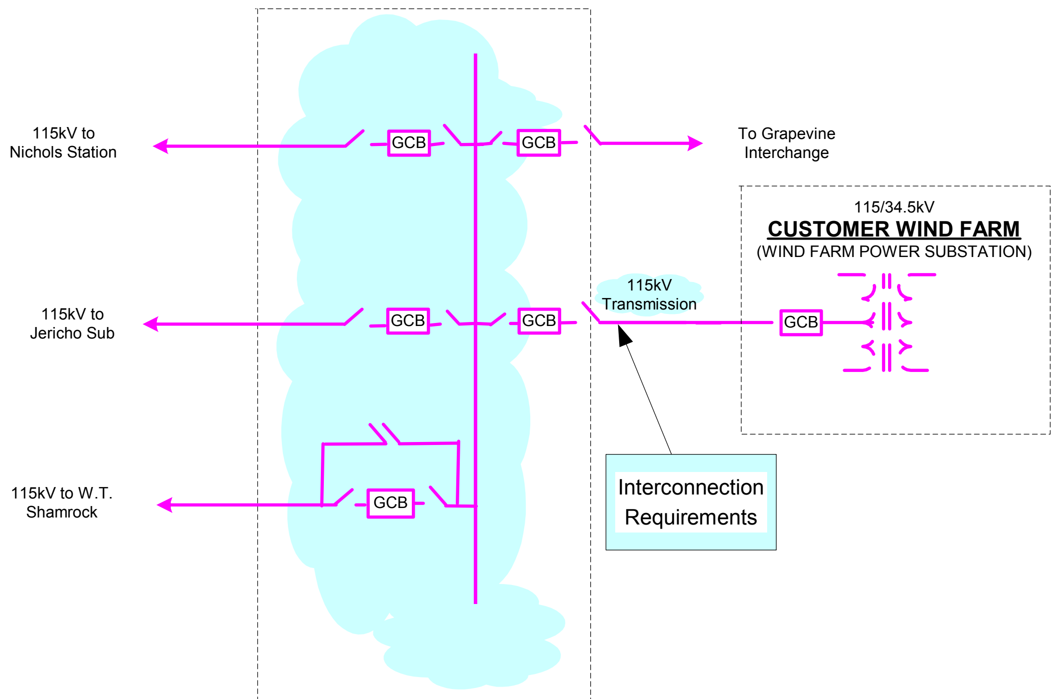
Construction Schedule

In order to complete all construction for this project in a timely manner, the estimated construction schedule is shown below and is contingent on the date an Interconnection Agreement is signed. If the agreement is not signed and construction funds have not been provided or approved prior to the date indicated, a new construction schedule would have to be drafted to accommodate any additional projects awaiting construction.

Customer 75 MW Wind Farm Project Construction Schedule



[1] The cost includes one 115 kV breaker line terminals and associated equipment.
[2] Transmission line from the wind farm to the new switching station. The cost is estimated for1/2 mile of 115 kV transmission line assuming no corner structures (i.e. straight line) are required. Cost to be adjusted accordingly pending exact configuration and location of site.



**KIRBY 115 kV
Switching
Station**

Figure 1, One-line Diagram of the 115 kV Interconnection Facility.

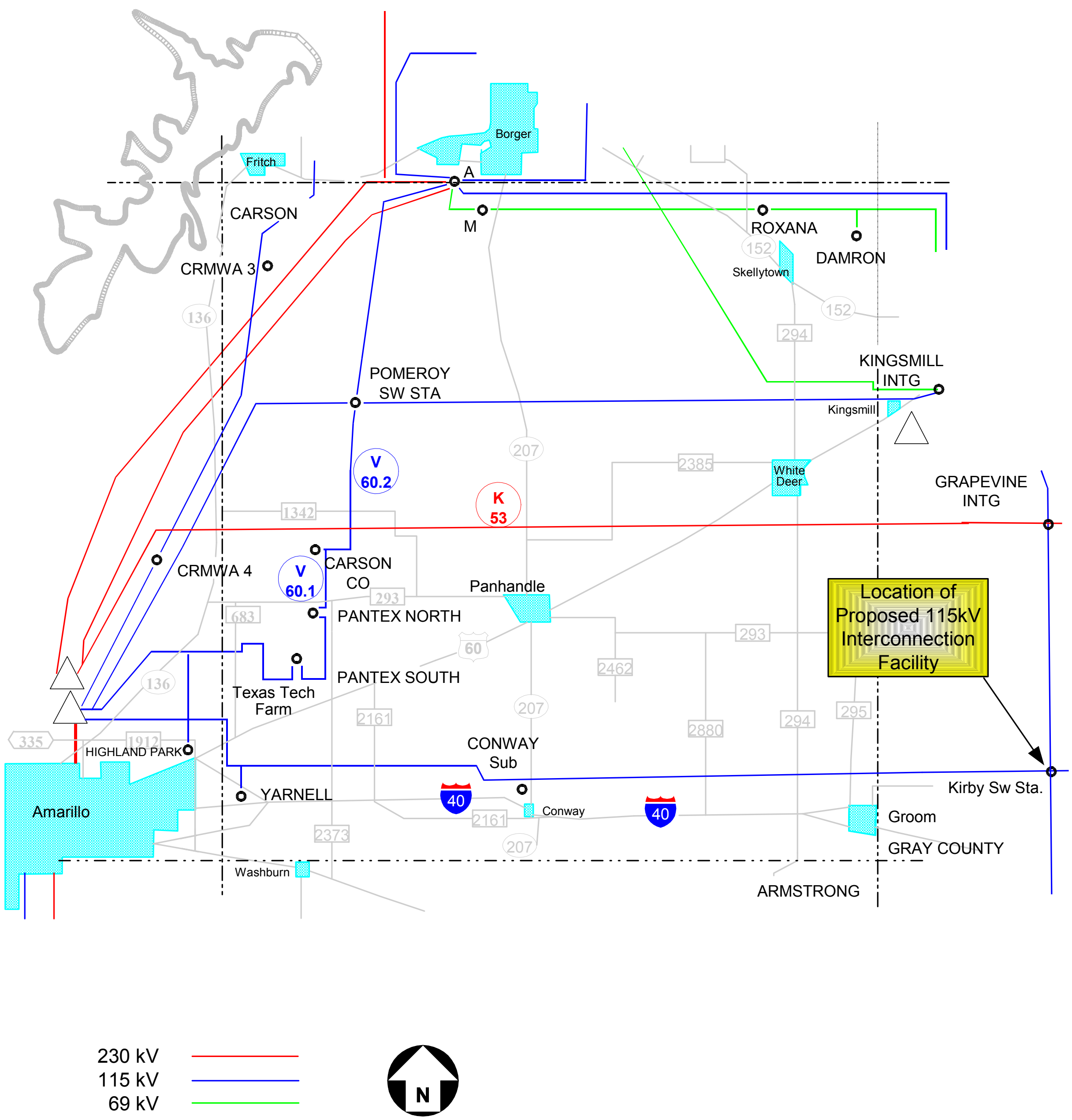


Figure 2. Local Transmission System